Environment CANADA Environnement
20229931 VOL 85- ISS 8 850800
EXC # 001
TD 171.5.C3 R43
REGIONAL PROGRAM REPORT (CANADA. EN
VIRONMENTAL PROTECTION SERVICE. PAC
OOFF

Environment Canada

Environnement Canada

Environmental Protection Service

Service de la protection de l'environnement

DEPARTMENT OF THE ENVIRONMENT
ENVIRONMENTAL PROTECTION SERVICE
PACIFIC REGION

WATER QUALITY DATA COLLECTED BY THE ENVIRONMENTAL PROTECTION SERVICE JULY 1982 AND 1983 RELATIVE TO EQUITY SILVER MINE, HOUSTON, B.C.

Regional Program Report No. 85-08

Report Preparation: G. Derksen
Field Program: M. Ross and M. Jones

August, 1985

ABSTRACT

Water quality studies were conducted at the Equity Silver Mine in July 1982 and July 1983. During the 1982 study the mine was having difficulty controlling acid mine drainage. The 1982 results relative to 1983 indicate that during a period of poor acid mine drainage control the water quality of receiving streams is severely impacted upon.

TABLE OF CONTENTS

		Page
ABSTRACT		i
TABLE OF CONTENTS		ii
	List of Figures	iii
	List of Tables	iv
SUMMARY		v
1.	INTRODUCTION	1
2.	DESCRIPTION OF STUDY AREA	3
3.	MATERIALS AND METHODS	5
3.1	Inorganics (excluding metals) and Temperature	5
3.2	Total and Dissolved Metals and Hardness	5
4.	OBJECTIVES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE	6
5.	RESULTS AND DISCUSSION	7
5.1	Creek Samples	7
5.1.1	1982 Creek Results	7
5.1.2	1983 Creek Results	13
5.1.3	Water Quality Objectives Comparison	13
5.2	Goosly Lake Samples	13
REFERENCES		19
ACKNOWLEDGEMENTS		20
APPENDIX I	EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS	21
APPENDIX II	GOOSLY LAKE WATER CHEMISTRY	61

LIST OF FIGURES

Figure		Page
1	EQUITY SILVER MINE - EPS WATER QUALITY MONITORING STATIONS	2

LIST OF TABLES

Table		Page
1	EPS SAMPLE STATION DESCRIPTION	4
2	MEAN WATER QUALITY OF FOXY CREEK, BESSEMER CREEK, AND BUCK CREEK JULY 21/22, 1982 AND JULY 18/19, 1983 [Inorganics (excluding metals) and Temperature]	8
3	MEAN WATER QUALITY OF FOXY CREEK, BESSEMER CREEK, AND BUCK CREEK, JULY 21/22, 1982 AND JULY 18/19, 1983 (Total and Dissolved Metals and Hardness)	9
4	RECOMMENDED SURFACE FRESHWATER QUALITY OBJECTIVES FOR AQUATIC LIFE	15
5	WATER QUALITY PARAMETER SCREENING TABLE FOR SALMONID HATCHERIES	16
6	RANGE OF WATER QUALITY VALUES FOR GOOSLY LAKE JULY 1982 AND JULY 1983	18

SUMMARY

During the July 1982 survey the water quality of the creeks adjacent to the Equity Mine site were heavily impacted upon. The most noteable effect was on Bessemer Creek with field pH levels of 5.2, mean total and dissolved copper levels of 2000 and 1540 ug/l respectively and total and dissolved zinc levels of 1397 and 1210 ug/l respectively. The mean total cadmium concentration was 10.3 ug/l. The influence of Bessemer Creek was detectable on Buck Creek just upstream of Goosly Lake. The July 1982 mean total copper and mean total zinc levels of Foxy Creek downstream of the mine site (91 ug/l and 116 ug/l respectively) were noteably higher than the controls (4 ug/l and 3 ug/l respectively).

The July 1983 survey indicated that the influence of acid mine drainage was much reduced. Bessemer Creek had elevated mean total and dissolved copper (83 and 49 ug/l respectively) concentrations and mean total and dissolved zinc (192 and 131 ug/l respectively) concentrations. Bessemer Creek did not appear to have caused any elevation in copper or zinc levels in Buck Creek.

The degree of some of the replicate variability noted in some of the control station copper and zinc concentrations could make it difficult to distinguish all but the most obvious impacts. This was more pronounced in the 1982 survey. Further replicated sampling is required to determine the extent of this variability.

1. INTRODUCTION

Equity Silver Mines is located approximately 33 km southeast of Houston, B.C. (Figure 1). The mine began production in September 1980. In November 1981 it was determined that waste rock at the mine site was generating acid and acid mine drainage was entering Bessemer Creek. The company constructed a temporary acid mine drainage collection system in Spring 1982 and has continued to make improvements to the collection and treatment system since then.

The Environmental Protection Service undertook monitoring programs in July 1982 and July 1983 to assess the water quality of the watersheds adjacent to the Equity mine site. This report presents the data collected July 21-22, 1982 and July 18-19, 1983.

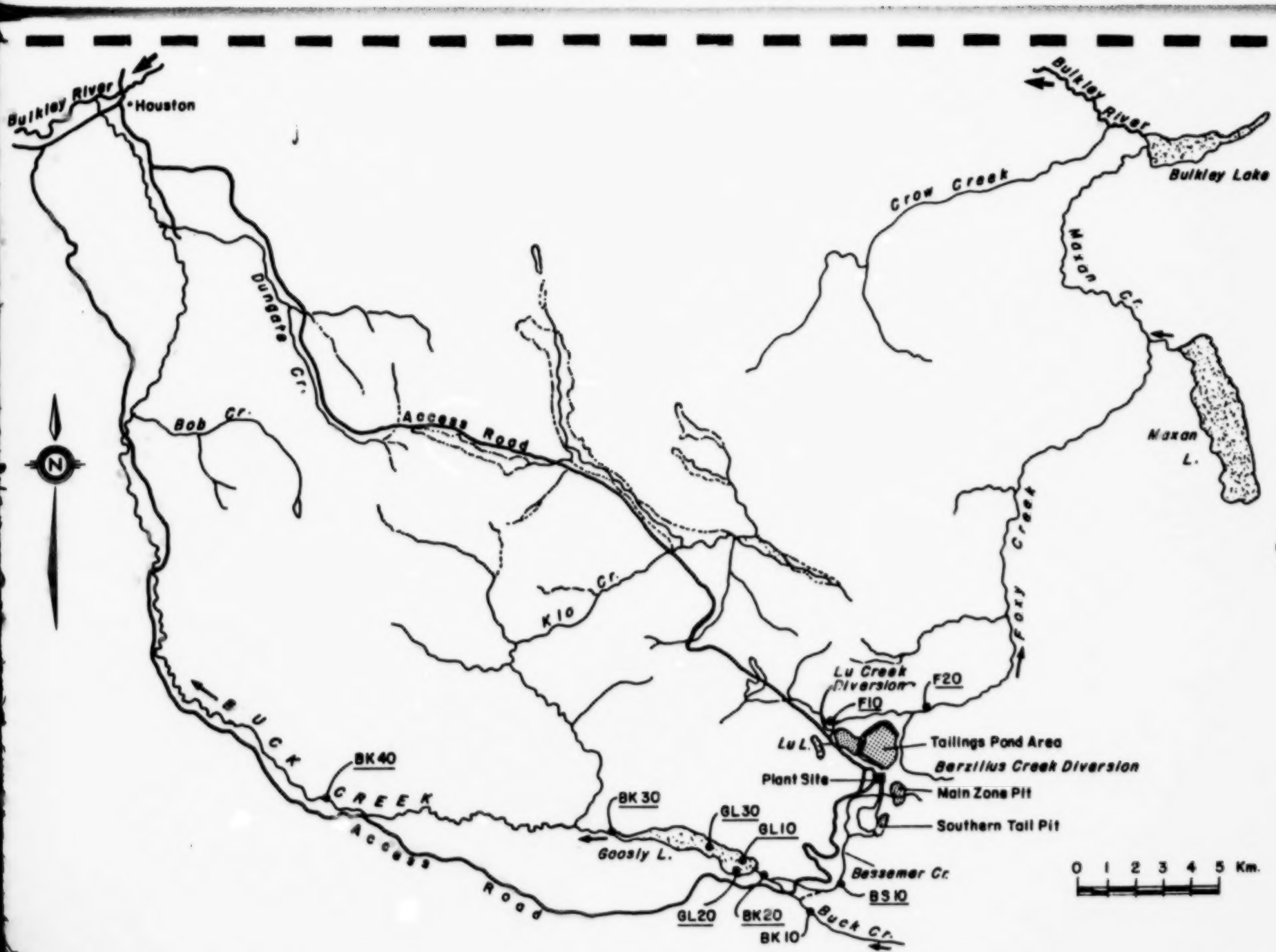

FIGURE 1 EQUITY SILVER MINE - EPS WATER QUALITY MONITORING STATIONS

2. DESCRIPTION OF STUDY AREA

The Equity Mine site is centered on the Foxy Creek and Bessemer Creek watersheds. Foxy Creek is a tributary of Maxan Creek which flows into Bulkley Lake. Bessemer Creek is a tributary of Buck Creek upstream of Goosly Lake. Buck Creek downstream of Goosly Lake flows into the Bulkley River at Houston (Figure 1).

Seven creek stations were sampled during the surveys and three stations were sampled on Goosly Lake. The sample stations are described in Table 1 and are shown in Figure 1.

TABLE 1 EPS SAMPLE STATION DESCRIPTION

EPS STATION	CORRESPONDING WMB STATION	DESCRIPTION*
Foxy Creek		
F10	0400763	- Approximately 30 m upstream of Lu Creek diversion channel
F20	0400764	- Approximately 45 m downstream of Berzilius Creek diversion channel
Bessemer Creek		
BS10	0700081	- Approximately 2 km upstream of Buck Creek confluence
Buck Creek		
BK10	0400765	- Upstream of Bessemer Creek influence, approximately 540 m upstream of Buck Creek road bridge
BK20	0400766	- Approximately 15 m upstream of Goosly Lake inlet, downstream of Bessemer Creek confluence
BK30	0700085	- Goosly Lake outlet at Buck Creek
BK40	0700086	- Ferris Property approximately 11 km downstream of Goosly Lake outlet
Goosly Lake		
GL10	0700082	- NE end of Goosly Lake
GL20	0700083	- SE end of Goosly Lake
GL30	0700084	- Mid Goosly Lake

*See Figure 1

3. MATERIALS AND METHODS

3.1 Inorganics (excluding metals) and Temperature

Three grab samples were collected sequentially at the creek stations. Single samples were collected with a Van Dorn water bottle at four depths for each lake station in 1982 and three depths in 1983.

Field pH samples were measured with a Metrohm Model E588 pH Meter. Samples for conductivity, turbidity, residue, sulfate, and pH were collected in a 2.5 litre polyethylene sample bottle. These samples were kept cool until analyzed at the EPS/DFO Cypress Creek Laboratory in West Vancouver (Anon, 1979).

3.2 Total and Dissolved Metals and Hardness

Total metal samples were collected in a 200 ml acid washed polyethylene sample bottle and preserved with 1 ml of nitric acid. Dissolved metal samples were filtered on site through a 0.45 u cellulose nitrate membrane filter into a 100 ml acid washed polyethylene sample bottle and preserved with 0.5 ml of nitric acid. Total and dissolved metals were analyzed by Inductively Coupled Argon Plasma (ICAP) Atomic Emission Spectrophotometry (Anon, 1979). For copper, lead, and cadmium, if the concentration was below the ICAP detection limit the sample was re-analyzed by flameless (graphite furnace) Atomic Absorption Spectrophotometry (AAS) to obtain a lower detection limit (Anon, 1979). Arsenic was analyzed using an ICAP hydride method (Anon, 1979).

Total hardness was computed automatically from the dissolved metal sample. Creek temperature was measured with a pocket thermometer. Temperature profiles of Goosly Lake were not measured.

4. OBJECTIVES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

For evaluation purposes, the concentrations of specific metals can be compared to recommended Environment Canada objectives (Reeder, 1979) for the protection of freshwater aquatic life. The reader should consider the rational for the development and use of these objectives.

An objective is a designated concentation of a constituent that when not exceeded, will protect an organism, a community of organisms, a prescribed water use, or a designated multiple-purpose water use with an adequate degree of safety (Reeder 1979). Objectives represent scientific judgements based upon the best available information relevant to Canadian surface waters on the relationships between toxic substances and water use and on the concentration-effect relationships between toxic substances and biological or environmental receptors. They should not be used as absolute values for water quality but with considered judgement and with an understanding of their development. The judgement in their use should include a thorough knowledge of the natural quality of the water under consideration, the kinds of organisms it contains and the local hydrological conditions. The Environment Canada objectives are based on a total metal concentration for the following reasons: (1) adequate toxicity data are not available for most chemical species; (2) toxicities of many metal constituents in water correlate well with the "free ion" concentraton but methods for measuring "free ion" concentrations routinely are not presently available; (3) many constituents enter the water system adsorbed on, or adsorbed in, particulate matter and are subsequently released to the water by chemical, physical, and microbial action and (4) at the present time there is insufficient information available to allow the determination of the fraction of toxicants present in the suspended matter which is biologically available, thus "total" will represent a maximum limit for the biologically available material.

5. RESULTS AND DISCUSSION

5.1 Creek Samples

The main difference between the July 1982 and July 1983 results is the obvious influence of acid mine drainage. During the 1982 survey period the mine was having difficulty controlling the acid water.

A summary of mean water quality for the creek stations is reported in Tables 2 and 3. Individual replicate results are reported in Appendix I.

5.1.1 1982 Creek Results. The impact of acid mine drainage on Bessemer Cr. water quality (BS10) was evident on July 21, 1982. The field pH of Bessemer Cr. was 5.2 and the laboratory result was 4.6 (Table 2). The negative influence of Bessemer Cr. on Buck Cr. (BK20) water quality was also apparent (Table 2 and 3). For example, Bessemer Cr. had a mean total copper concentration of 2000 ug/l on July 21, 1985 (Table 3). This was reflected by a mean concentration of 115 ug/l at BK20 compared to 1 ug/l at the control BK10. For Buck Cr. stations BK10 and BK40 the dissolved copper results are unexplainably higher than the totals (Appendix I). For zinc, Bessemer Cr. (BS10) had a mean total zinc concentration of 1397 ug/l. Buck Cr. station BK20 had a mean total zinc concentration of 75 ug/l compared to 4 ug/l at the control BK10 (Table 3).

On July 21, 1982 the influence of mine drainage was also evident on Foxy Creek. For example, Foxy Cr. downstream of the mine property (F20) had a mean total copper concentration of 91 ug/l compared to 4 ug/l at the control F10 (Table 3). For total zinc, station F20 had a mean concentration of 116 ug/l compared to 3 ug/l at the control F10.

Cadmium was only detectable in the Bessemer Cr. samples. The mean total cadmium concentration of 10.3 ug/l at BS10 was lower than the mean dissolved cadmium concentraiton of 13.3 ug/l (Table 3). The highest mean conductivity (650 umhos/cm), turbidity (475 FTU's), total residue (851 mg/l), non-filterable residue (373 mg/l), sulfate (278 mg/l), and hardness (255 mg/l as $CaCO_3$) levels were recorded in Bessemer Creek (Tables 2 and 3).

TABLE 2 MEAN WATER QUALITY OF FOXY CREEK, BESSEMER CREEK AND BUCK CREEK, JULY 21/22, 1982 AND JULY 18/19, 1983
[Inorganics (excluding metals) and Temperature]

PARAMETER					PARAMETER				
STATION	JULY 1982		JULY 1983		STATION	JULY 1982		JULY 1983	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.		$\bar{x}$	S.D.	$\bar{x}$	S.D.
	CONDUCTIVITY (umhos/cm)					SULFATE (mg/l)			
F10	60.6	0.3	41.6	0.0	F10	12.1	0.0	3.8	0 3
F20	126	0.6	73.8	0.0	F20	37.7	0.2	12.8	0.1
BS10	650	5.8	543	0.0	BS10	278	2.9	203	1.5
BK10	102	1.0	89	0.0	BK10	4.5	0.1	5.2	0.2
BK20	215	0.6	147	1.7	BK20	60.7	0.3	28.8	0.4
BK30	100	0.0	106	0.6	BK30	15.3	0.3	16.9	0.2
BK40	61	0.0	78.1	0.0	BK40	4.3	0.3	9.9	6.3
	TURBIDITY (FTU)					pH (laboratory)*			
F10	3.2	0.7	0.2	0.0	F10	6.8		7.0 - 7.1	
F20	35.7	1.1	1.0	0.3	F20	6.8 - 6.9		7.3	
BS10	475	0.0	4.8	0.0	BS10	4.6		7.4 - 7.5	
BK10	2.0	0.3	1.1	0.0	BK10	6.8 - 7.0		7.4	
BK20	7.4	0.1	1.4	0.1	BK20	7.0		7.0 - 7.2	
BK30	0.9	0.1	0.6	0.1	BK30	7.3		7.5	
BK40	7.5	0.0	1.5	0.0	BK40	7.5		7.6	
	TOTAL RESIDUE (mg/l)					pH (field)*			
F10	79	2.0	71	12.9	F10	7.1 - 7.3		7.3 - 7.5	
F20	160	1.5	81	4.6	F20	7.1 - 7.3		7.7 - 7.7	
BS10	851	9.2	430	0.6	BS10	5.2		7.8	
BK10	101	1.7	102	2.6	BK10	7.3 - 7.5		7.6 - 7.7	
BK20	174	0.0	138	3.1	BK20	7.4 - 7.6		7.1 - 7.3	
BK30	109	3.5	99	2.3	BK30	7.7 - 7.9		8.1 - 8.2	
BK40	104	2.1	89	1.0	BK40	7.7		8.4	
	NON-FILTERABLE RESIDUE (mg/l)					TEMPERATURE (°C)			
F10	< 5	0.0	< 5	0.0	F10	7.0		10	
F20	45	1.5	< 5	0.0	F20	7.5		12	
BS10	373	6.5	12	1.7	BS10	8.0		12.5	
BK10	< 5	0.0	< 5	0.0	BK10	-		13	
BK20	7.3	2.1	< 5	0.0	BK20	10.0		14	
BK30	< 5	0.0	< 5	0.0	BK30	15.0		19	
BK40	22	0.0	< 5	0.0	BK40	12.5		16	

*range

NOTE: n = 3, detection limit used in mean calculation, see Appendix I for tabulated data

TABLE 3 MEAN WATER QUALITY OF FOXY CREEK, BESSEMER CREEK AND BUCK CREEK, JULY 21/22, 1982 AND JULY 18/19, 1983 (Total and Dissolved Metals and Hardness)

STATION	JULY 1982 $\bar{x}$	JULY 1982 S.D.	JULY 1983 $\bar{x}$	JULY 1983 S.D.
HARDNESS (mg/l as $CaCO_3$)				
F10	26.1	.3	19.7	.3
F20	53	.7	34.2	.1
BS10	255	1.2	256	1.5
BK10	50.2	1.2	47.4	.5
BK20	90.3	1.8	72.1	2.0
BK30	42.6	.2	47.7	.4
BK40	26.2	.2	34.2	.2
TOTAL ALUMINUM (mg/l)				
F10	.59	.02	.23	.03
F20	2.59	.25	.30	.02
BS10	19.0	.59	1.28	.03
BK10	.23	.04	.34	.13
BK20	.69	.08	.12	.01
BK30	.10	.01	.06	.01
BK40	.95	.04	.28	.02
DISSOLVED ALUMINUM (mg/l)				
F10	.14	.01	.10	.01
F20	.08	.01	.08	.00
BS10	1.68	.02	.15	.01
BK10	< .05	.00	.08	.01
BK20	.07	.01	< .05	.00
BK30	< .05	.00	< .05	.00
BK40	.05	.01	.05	.01
TOTAL ARSENIC (ug/l)				
F10	< 0.5	.0	-	-
F20	7.3	.8	-	-
BS10	82.2	2.6	-	-
BK10	1.5	.6	-	-
BK20	2.0	.1	-	-
BK30	0.7	.3	-	-
BK40	< 0.5	.0	-	-

STATION	JULY 1982 $\bar{x}$	JULY 1982 S.D.	JULY 1983 $\bar{x}$	JULY 1983 S.D.
TOTAL CADMIUM (ug/l)				
F10	< 0.6	.0	< 0.5	.0
F20	< 0.6	.0	< 0.5	.0
BS10	10.3	.6	1.7	.2
BK10	< 0.6	.0	< 0.5	.0
BK20	< 0.6	.0	< 0.5	.0
BK30	< 0.6	.0	< 0.5	.0
BK40	< 0.6	.0	< 0.5	.0
DISSOLVED CADMIUM (ug/l)				
F10	< 0.5	.0	< 0.5	.0
F20	< 0.5	.0	< 0.5	.0
BS10	13.3	.6	1.5	.1
BK10	< 0.5	.0	< 0.5	.0
BK20	< 0.5	.0	< 0.5	.0
BK30	< 0.5	.0	< 0.5	.0
BK40	< 0.5	.0	< 0.5	.0
TOTAL CALCIUM (mg/l)				
F10	5.8	.1	4.5	.2
F20	14.5	.1	9.4	.1
BS10	69.9	.2	72.4	.2
BK10	13.1	.2	12.0	.2
BK20	24.7	.3	18.3	.5
BK30	11.7	.1	12.6	.2
BK40	6.7	.0	8.1	.1
DISSOLVED CALCIUM (mg/l)				
F10	6.0	.1	4.7	.1
F20	14.3	.2	9.6	.0
BS10	67.7	.2	76.3	.4
BK10	13.3	.4	12.7	.2
BK20	24.7	.5	19.9	.5
BK30	11.5	.1	12.9	.1
BK40	6.2	.0	8.3	.1

NOTE: n = 3, detection limit used in mean calculation, see Appendix I for tabulated data

TABLE 3 CONTINUED

STATION	PARAMETER			
	JULY 1982		JULY 1983	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.
	TOTAL CHROMIUM (ug/l)			
F10	< 6	0	< 5	0
F20	< 6	0	< 5	0
BS10	13	3	< 5	0
BK10	< 6	0	< 5	0
BK20	< 6	0	< 5	0
BK30	< 6	0	< 5	0
BK40	< 6	0	< 5	0
	DISSOLVED CHROMIUM (ug/l)			
F10	< 5	0	< 5	0
F20	< 5	0	< 5	0
BS10	< 5	0	< 5	0
BK10	< 5	0	< 5	0
BK20	< 5	0	< 5	0
BK30	< 5	0	< 5	0
BK40	< 5	0	< 5	0
	TOTAL COPPER (ug/l)			
F10	4	3	< 1	0
F20	91	0	2	0
BS10	2000	10	83	2
BK10	1	0	< 1	0
BK20	115	2	$\leq$ 1	0
BK30	8	6	2	1
BK40	2	0	< 1	0
	DISSOLVED COPPER (ug/l)			
F10	2	1	< 1	0
F20	58	2	2	1
BS10	1540	12	49	1
BK10	7	8	< 1	0
BK20	76	3	$\leq$ 1	0
BK30	9	3	2	1
BK40	4	2	< 1	0

STATION	PARAMETER			
	JULY 1982		JULY 1983	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.
	TOTAL IRON (ug/l)			
F10	534	26	186	6
F20	2710	190	279	33
BS10	25600	600	1210	20
BK10	830	67	727	145
BK20	1580	130	1100	100
BK30	265	20	168	10
BK40	1170	40	447	11
	DISSOLVED IRON (ug/l)			
F10	165	38	105	3
F20	119	7	88	6
BS10	1590	30	133	3
BK10	478	8	430	5
BK20	502	27	850	59
BK30	130	19	101	1
BK40	176	15	171	19
	TOTAL LEAD (ug/l)			
F10	< 1	0	< 1	0
F20	< 1	0	< 1	0
BS10	< 1	0	< 1	0
BK10	< 1	0	< 1	0
BK20	< 1	0	< 1	0
BK30	2	2	< 1	0
BK40	$\leq$ 1	0	< 1	0
	DISSOLVED LEAD (ug/l)			
F10	< 1	0	< 1	0
F20	< 1	0	< 1	0
BS10	< 1	0	< 1	0
BK10	< 1	0	< 1	0
BK20	< 1	0	< 1	0
BK30	< 1	0	< 1	0
BK40	$\leq$ 1	0	< 1	0

NOTE: n = 3, detection limit used in mean calculation, see Appendix I for tabulated data

TABLE 3 CONTINUED

STATION	PARAMETER			
	JULY 1982		JULY 1983	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.
	TOTAL MAGNESIUM (mg/l)			
F10	2.5	.1	1.8	.0
F20	4.3	.0	2.4	.0
BS10	19.2	.1	14.7	.3
BK10	3.8	.1	3.4	.1
BK20	6.5	.1	4.8	.1
BK30	3.3	.0	3.6	.1
BK40	2.7	.0	3.2	.0
	DISSOLVED MAGNESIUM (mg/l)			
F10	2.4	.0	1.7	.1
F20	3.8	.1	2.3	.0
BS10	15.7	.1	14.4	.1
BK10	3.8	.1	3.4	.0
BK20	6.4	.1	4.9	.1
BK30	3.2	.1	3.6	.1
BK40	2.4	.0	3.1	.0
	TOTAL MANGANESE (ug/l)			
F10	17	0	9	0
F20	230	1	15	0
BS10	3183	12	626	11
BK10	68	7	46	13
BK20	252	9	108	10
BK30	19	1	12	0
BK40	73	1	29	0
	DISSOLVED MANGANESE (ug/l)			
F10	10	5	5	1
F20	169	3	8	0
BS10	2860	17	644	5
BK10	53	14	26	2
BK20	223	6	112	8
BK30	6	1	2	0
BK40	12	0	17	0

STATION	PARAMETER			
	JULY 1982		JULY 1983	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.
	TOTAL MOLYBDENUM (ug/l)			
F10	< 6	0	< 5	0
F20	< 6	0	< 5	0
BS10	7	2	< 5	0
BK10	< 6	0	< 5	0
BK20	< 6	0	< 5	0
BK30	< 6	0	< 5	0
BK40	< 6	0	< 5	0
	DISSOLVED MOLYBDENUM (ug/l)			
F10	6	2	< 5	0
F20	< 5	0	< 5	0
BS10	< 5	0	< 5	0
BK10	< 5	0	< 5	0
BK20	< 5	0	< 5	0
BK30	< 5	0	< 5	0
BK40	< 5	0	< 5	0
	TOTAL NICKEL (mg/l)			
F10	< .02	.00	< .02	.00
F20	< .02	.00	< .02	.00
BS10	.18	.02	.06	.01
BK10	< .02	.00	< .02	.00
BK20	< .02	.00	< .02	.00
BK30	< .02	.00	< .02	.00
BK40	< .02	.00	< .02	.00
	DISSOLVED NICKEL (mg/l)			
F10	< .02	.00	< .02	.00
F20	< .02	.00	< .02	.00
BS10	.15	.01	.06	.00
BK10	< .02	.00	< .02	.00
BK20	< .02	.00	< .02	.00
BK30	< .02	.00	< .02	.00
BK40	< .02	.00	< .02	.00

NOTE: n = 3, detection limit used in mean calculation, see Appendix I for tabulated data

TABLE 3 CONTINUED

STATION	PARAMETER			
	JULY 1982		JULY 1983	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.
	TOTAL STRONTIUM (ug/l)			
F10	69	1	48	1
F20	283	1	182	2
BS10	1536	6	3290	101
BK10	127	6	130	3
BK20	356	4	289	12
BK30	132	1	158	5
BK40	58	0	77	1
	DISSOLVED STRONTIUM (ug/l)			
F10	71	0	50	1
F20	289	7	185	2
BS10	1573	15	3573	42
BK10	137	8	144	8
BK20	385	12	322	12
BK30	138	0	159	3
BK40	55	1	75	1
	TOTAL ZINC (ug/l)			
F10	3	1	< 2	0
F20	116	1	< 2	0
BS10	1397	6	192	2
BK10	4	3	< 2	0
BK20	75	8	< 2	0
BK30	10	7	2	1
BK40	7	7	$\underline{<}$ 2	0
	DISSOLVED ZINC (ug/l)			
F10	3	0	4	3
F20	81	4	3	0
BS10	1210	0	131	1
BK10	5	5	$\underline{<}$ 2	0
BK20	53	1	2	1
BK30	5	2	< 2	0
BK40	< 2	0	< 2	0

STATION	PARAMETER			
	JULY 1982		JULY 1983	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.
	TOTAL TITANIUM (ug/l)			
F10	23	1	9	1
F20	80	10	11	1
BS10	369	22	22	1
BK10	4	1	12	5
BK20	9	3	5	0
BK30	2	1	< 2	0
BK40	50	3	15	1
	DISSOLVED TITANIUM (ug/l)			
F10	< 2	0	3	1
F20	< 2	0	$\underline{<}$ 2	0
BS10	< 2	0	$\underline{<}$ 2	0
BK10	< 2	0	$\underline{<}$ 2	0
BK20	< 2	0	$\underline{<}$ 2	0
BK30	< 2	0	< 2	0
BK40	< 2	0	$\underline{<}$ 2	0

NOTE: n = 3, detection limit used in mean calculation, see Appendix I for tabulated data

There were a few unusual results in the 1982 data set. For copper, there was a large variability in total copper concentrations at F10 (< 1-6 ug/l) and dissolved copper at BK10 (2-16 ug/l) (Appendix I). For zinc, there was a large variability in total zinc at BK10 (< 2-8 ug/l) and BK40 (3-16 ug/l). For dissolved zinc there was a large variability at BK10 (< 2-10 ug/l).

5.1.2 1983 Creek Results. The extreme contamination of Bessemer Cr. by acid mine drainage in July 1982 was not evident in July 1983. The field pH of Bessemer Cr. was 7.8 while the laboratory pH was 7.4 (Table 2). While Bessemer Cr. (BS10) had high mean total copper and zinc concentrations (83 ug/l and 192 ug/l respectively) this was not reflected in Buck Cr. (BK20) water quality results (Table 3). During the 1983 survey, copper and zinc contamination of Foxy Creek by mine drainage was not evident (Table 3). Cadmium was only detected at station BS10 and the mean total concentration was 1.7 ug/l. There was a large variability in the dissolved zinc concentrations at station F10 (< 2-8 ug/l) (Appendix I).

5.1.3 Water Quality Objectives Comparison. Environment Canada (Inland Waters Directorate) has published recommended surface water quality objectives for aquatic life (Reeder, 1979). Stations that exceeded these recommended objectives are reported in Table 4. The Department of Fisheries and Oceans have had water quality criteria prepared for the assessment and screening of water quality supplies for salmonid hatcheries (Sigma, 1983). Stations that did not meet these levels are reported in Table 5. The reader is advised to refer to both reports for a complete discussion on the use and development of the recommended levels.

5.2 Goosly Lake Samples

The range of water quality values for Goosly Lake on July 22, 1982 and July 19, 1983 are reported in Table 6. The individual sample results are reported in Appendix II. As temperature profiles were not

taken it is not possible to determine concentration gradients relative to a thermocline.

The July 1982 samples were collected during a period of strong acid mine influence on Bessemer Creek and Buck Creek just upstream of Goosly Lake. The results in general appear to indicate values are similar to those in July 1983 when acid mine drainage was not evident. Those results that do appear to be elevated in 1982 relative to 1983 include total aluminum, total and dissolved copper, total and dissolved iron and total and dissolved zinc (Appendix II). For copper in 1982, the dissolved values are generally higher than the total values.

There are several unusual values in the 1982 and 1983 data sets. For 1982, at station GL30 (5 m) the dissolved chromium (28 mg/l) and dissolved iron (220 ug/l) appear to be unexplainably high (Appendix II). For 1983, at station GL10 (8 m) the high turbidity (2.5 JTU's) may indicate the sampler disturbed the bottom sediments. The only metal results that support this premise are high total and dissolved manganese (Appendix II).

TABLE 4 RECOMMENDED SURFACE FRESHWATER QUALITY OBJECTIVES* FOR AQUATIC LIFE

CONSTITUENT	OBJECTIVE CONCENTRATION (ug/L) (as Total)	STATIONS THAT EXCEEDED OBJECTIVE	
		1982	1983
Arsenic	50	- BS10 $\overline{x}$ = 82	- not sampled
Cadmium	0.2	- BS10 $\overline{x}$ = 10.3 - Other stations < 0.6	- BS10 $\overline{x}$ = 1.7 - Other stations < 0.5
Chromium	40	-	-
Copper	2	- F10 $\overline{x}$ = 4, F20 $\overline{x}$ = 91 - BS10 $\overline{x}$ = 2000 - BK20 $\overline{x}$ = 115, BK30 $\overline{x}$ = 8	- BS10 $\overline{x}$ = 83
Lead	5 (hardness < 95 mg/L as $CaCO_3$) 10 (hardness > 95 mg/L as $CaCO_3$; waters with sensitive species of fish 3 (hardness > 95 mg/L as $CaCO_3$; sensitive species of fish absent)	-	-
Mercury	0.1 (to protect consumers of fish) 0.2 (where fish not eaten)	- not sampled	- not sampled
Nickel	25 (soft water) 250 (hardness > 95 mg/L as $CaCO_3$)	-	-
Selenium	10	- not sampled	- not sampled
Silver	0.1	- not sampled	- not sampled
Zinc	50 (hardness 0-120 mg/L as $CaCO_3$) 100 (hardness 120-180 mg/L as $CaCO_3$) 200 (hardness 180-300 mg/L as $CaCO_3$) 300 (hardness > 300 mg/L as $CaCO_3$)	- F20 $\overline{x}$ = 116 - BS10 $\overline{x}$ = 1397 - BK20 $\overline{x}$ = 75	(BS10 $\overline{x}$ = 192 but hardness was 256 mg/l as $CaCO_3$)

*Format modified after Reeder, 1979
NOTE: Refer to Table 3 for station hardness

TABLE 5 WATER QUALITY PARAMETER SCREENING TABLE FOR SALMONID HATCHERIES*

FISH CULTURE PARAMETERS	RECOMMENDED SCREENING LEVELS	STATIONS THAT DO NOT MEET SCREENING LEVEL	
		July 1982	July 1983
Alkalinity[1]	> 15 mg/L as $CaCO_3$	- not sampled	- not sampled
Hardness[2]	> 20 mg/L as $CaCO_3$	-	-
pH[3]	7.2 to 8.5	- BS10 pH = 5.2	-
Suspended Solids[4]	< 3 mg/L	- F20 $\bar{x}$ = 45 - BS10 $\bar{x}$ = 373 - BK20 $\bar{x}$ = 7.3 - BK40 $\bar{x}$ = 22 (detection limit 5 mg/l)	- BS10 $\bar{x}$ = 12 (detection limit 5 mg/l)

METALS	MAXIMUM ACCEPTABLE LEVELS (ug/L)	HARDNESS (mg/L $CaCO_3$)	STATIONS THAT DO NOT NEED SCREENING LEVEL	
			July 1982	July 1983
Aluminum (total)[5]	100		- All stations except BK30 exceeded this level	- All stations except BK30 exceeded this level
Cadmium (dissolved)	0.3	- 10	- BS10 $\bar{x}$ = 13.3, all other stations < 0.5	- BS10 $\bar{x}$ = 1.5, all other stations < 0.5
	0.4	- 50		
	0.5	- 100		
	0.75	- 300		
Chromium (total)	40		-	-
Copper (dissolved)	2	- 10	- F20 $\bar{x}$ = 58	(BS10 $\bar{x}$ = 49 but $\bar{x}$ hardness was 256 mg/L as $CaCO_3$)
	5	- 25	- BS10 $\bar{x}$ = 1540	
	11	- 50	- BK20 $\bar{x}$ = 76	
	22	- 120		
	64	- 300		
Iron (total)[5]	300		- All stations except BK30 exceeded this level	- All stations except F10 and BK30 exceeded this level
Mercury (total)	0.2		- not sampled	- not sampled
Manganese (total)[5]	100		- F20 $\bar{x}$ = 230 - BS10 $\bar{x}$ = 3183 - BK20 $\bar{x}$ = 252	- BS10 $\bar{x}$ = 626 - BK20 $\bar{x}$ = 108

CONTINUED...

TABLE 5 CONTINUED

METALS	MAXIMUM ACCEPTABLE LEVELS (ug/L)	HARDNESS (mg/L $CaCO_3$)	STATIONS THAT DO NOT MEET SCREENING LEVEL	
			July 1982	July 1983
Nickel (total)	45 250	- < 150 - > 150	-	-
Lead (total)	4 10 25 50 100	0 - 35 35 - 75 75 - 150 150 - 300 300	-	-
Selenium (total)	50		- not sampled	- not sampled
Silver (dissolved)	0.1 0.15	0 - 150 150 - 300	- not sampled	- not sampled
Zinc (dissolved)	15 35 66 121 311	- 10 - 25 - 50 - 100 - 300	- F20 $\bar{x}$ = 81 - BS10 $\bar{x}$ = 1210 (BK20 $\bar{x}$ = 53 but $\bar{x}$ hardness was 90 mg/l as $CaCO_3$)	(BS10 $\bar{x}$ = 131 but $\bar{x}$ hardness was 256 mg/l as $CaCO_3$)

*Format modified from Sigma, 1983
NOTE: Refer to Table 3 for hardness

[1]This is a suggested minimum level of alkalinity to buffer pH changes in rearing ponds.

[2]This is a suggested minimum level of hardness to reduce risks of toxic effects of metals, low pH and poor fish health. Although insufficient data area available to establish specific criteria for hardness, the importance of hardness (the divalent metallic cations Ca^{2+}, Mg^{2+} and others) in reducing the toxic effects of metals, low pH, total gas pressure, and nitrite has been documented.

[3]A minimum inflow pH of 7.2 makes some allowance for the pH reduction due to CO_2 respiration in a rearing pond. Inflow pH criteria should be evaluated on site-specific basis with consideration of alkalinity, free CO_2 and fish loading density.

[4]The characteristics of the suspended solids should be carefully considered. For example, some materials (i.e. iron hydroxide precipitates) are toxic at lower concentrations than 3 mg/L.

[5]Analyses for total aluminum, iron, and manganese frequently result in high metal concentrations (exceeding the screening levels) if the water sample contains a significant quantity of suspended silt or clay. These mineral forms of the metal are essentially non-toxic. However, aluminum, iron and manganese precipitates are toxic. Their presence should be investigated if the total metal levels are high and the inert mineral fraction of the suspended solids appears to be relatively low.

TABLE 6 RANGE OF WATER QUALITY VALUES FOR GOOSLY LAKE JULY 1982 AND JULY 1983

PARAMETER	JULY 1982	JULY 1983	PARAMETER	JULY 1982	JULY 1983
Conductivity (umhos/cm)	97 - 104	103 - 111	Total Copper (ug/l)	4 - 12	1 - 4
Turbidity (FTU)	.7 - 1.0	.2 - 2.5	Dissolved Copper (ug/l)	4 - 8	1 - 2
Total Residue (mg/l)	96 - 115	97 - 105			
Non-Filterable Residue (mg/l)	< 5	< 5	Total Iron (ug/l)	202 - 410	164 - 426
Sulfate (mg/l)	15.2 - 16.0	15.8 - 17.8	Dissolved Iron (ug/l)	121 - 220	96 - 161
pH (laboratory)	7.2 - 7.3	7.0 - 7.6			
pH (field)	7.2 - 7.8	7.0 - 8.5	Total Magnesium (mg/l)	3.3 - 3.4	3.5 - 3.8
Temperature (°C)	-	-	Dissolved Magnesium (mg/l)	3.2 - 3.4	3.5 - 3.8
Hardness (mg/l as $CaCO_3$)	41.3 - 43.9	45.8 - 50.0			
			Total Manganese (ug/l)	11 - 26	13 - 110
Total Aluminum (mg/l)	< .06 - .22	< .05 - .19	Dissolved Manganese (ug/l)	< 1 - 10	1 - 62
Dissolved Aluminum (mg/l)	< .05	< .05			
			Total Molybdenum (ug/l)	< 6	< 5
Total Arsenic (ug/l)	< .5 - .63	-	Dissolved Molybdenum (ug/l)	< 5	< 5
Total Cadmium (ug/l)	< .6	< .5	Total Lead (ug/l)	< 1	< 1
Dissolved Cadmium (ug/l)	< .6	< .5	Dissolved Lead (ug/l)	< 1	< 1
Total Calcium (mg/l)	11.5 - 12.0	12.0 - 13.2	Total Strontium (ug/l)	129 - 139	144 - 174
Dissolved Calcium (mg/l)	11.0 - 11.8	12.4 - 13.6	Dissolved Strontium (ug/l)	134 - 149	146 - 176
Total Chromium (ug/l)	< 6	< 5	Total Titanium (ug/l)	< 2 - 4	< 2 - 9
Dissolved Chromium (ug/l)	< 5 - 28	< 5	Dissolved Titanium (ug/l)	< 2	< 2
			Total Zinc (ug/l)	2 - 10	< 2 - 6
			Dissolved Zinc (ug/l)	3 - 7	< 2 - 3

REFERENCES

Anon. Laboratory Manual, Department of Environment and Department of Fisheries and Oceans, Pacific Region (1979).

Reeder, S.W. Guidelines for Surface Water Ouality - Preamble. In Vol. 1 Inoragnic Chemical Substances. Inland Waters Directorate, Water Ouality Branch, Ottawa, Canada (1979).

Sigma. Summary of Water Ouality Criteria for Salmonid Hatcheries. Prepared for Department of Fisheries and Oceans. (1983).

ACKNOWLEDGEMENTS

Thanks are extended to summer students T. Wong and M. Peter for field support, L. Pearson for drafting, P. Wakeman for typing, and EPS Laboratory staff for chemical analyses.

Thanks are extended to B. Kelso and P. Mehling for reviewing this manuscript.

APPENDIX I

EQUITY SILVER
- RECEIVING WATER QUALITY DATA FOR CREEKS

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Conductivity - umhos/cm)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	60.4	61.0	60.4				41.6	41.6	41.6			
F20	126	126	125				73.8	73.8	73.8			
Bessemer Creek												
BS10	647	657	647				543	543	543			
Buck Creek												
BK10	101	103	102				89.0	89.0	89.0			
BK20				216	215	215				148	148	145
BK30				100	100	100				105	106	106
BK40				61.0	61.0	61.0				78.1	78.1	78.1

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Turbidity - FTU)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	3.0	4.0	2.7				0.2	0.2	0.2			
F20	35.0	37.0	35.0				1.3	0.8	0.8			
Bessemer Creek												
BS10	475	475	475				4.8	4.8	4.8			
Buck Creek												
BK10	2.0	2.3	1.7				1.1	1.1	1.1			
BK20				7.4	7.4	7.5				1.5	1.5	1.3
BK30				0.8	1.0	1.0				0.7	0.7	0.5
BK40				7.5	7.5	7.5				1.5	1.5	1.5

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Residue - mg/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	81	79	77				86	62	66			
F20	158	160	161				76	84	84			
Bessemer Creek												
BS10	862	846	846				430	429	430			
Buck Creek												
BK10	103	100	100				100	101	105			
BK20				174	174	174				137	135	141
BK30				109	113	106				98	102	98
BK40				102	105	106				89	88	90

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Non-Filterable Residue - mg/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	< 5	5	< 5				< 5	< 5	< 5			
F20	45	46	43				< 5	< 5	< 5			
Bessemer Creek												
BS10	380	367	374				11	11	14			
Buck Creek												
BK10	< 5	< 5	5				< 5	< 5	< 5			
BK20				8	9	< 5				< 5	< 5	< 5
BK30				< 5	< 5	< 5				< 5	< 5	< 5
BK40				22	22	22				< 5	< 5	< 5

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Sulfate - mg/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	12.1	12.1	12.1				4.0	3.5	3.9			
F20	37.7	37.9	37.6				12.8	12.8	12.7			
Bessemer Creek												
BS10	280	275	280				203	204	201			
Buck Creek												
BK10	4.6	4.5	4.4				5.4	5.1	27.9			
BK20				61.0	60.5	60.5				5.1	28.5	27.7
BK30				15.7	15.1	15.1				16.7	16.9	17.1
BK40				4.3	4.0	4.6				17.2	6.4	6.1

PPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (pH - laboratory)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	6.8	6.8	6.8				7.0	7.0	7.1			
F20	6.8	6.8	6.9				7.3	7.3	7.3			
Bessemer Creek												
BS10	4.6	4.6	4.6				7.4	7.5	7.4			
Buck Creek												
BK10	6.8	6.8	7.0				7.4	7.4	7.4			
BK20				7.0	7.0	7.0				7.2	7.2	7.0
BK30				7.3	7.3	7.3				7.5	7.5	7.5
BK40				7.5	7.5	7.5				7.6	7.6	7.6

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (pH - field)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	7.2	7.3	7.1				7.3	7.5	7.4			
F20	7.1	7.3	7.2				7.6	7.7	7.7			
Bessemer Creek												
BS10	5.2	5.2	5.2				7.8	7.8	7.8			
Buck Creek												
BK10	7.3	7.5	7.4				7.7	7.6	7.7			
BK20				7.5	7.6	7.4				7.1	7.3	7.2
BK30				7.7	7.7	7.9				8.1	8.2	8.2
BK40				7.7	7.7	7.7				8.4	8.4	8.4

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Temperature - °C)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	7	7	7				10	10	10			
F20	7.5	7.5	7.5				12	12	12			
Bessemer Creek												
BS10	8	8	8				12.5	12.5	12.5			
Buck Creek												
BK10	-	-	-				13	13	13			
BK20				10	10	10				14	14	14
BK30				15	15	15				19	19	19
BK40				12.5	12.5	12.5				16	16	16

APPENDIX I **EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS**

Parameter (Total Hardness - mg/l $CaCO_3$)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	26.4	26	25.8				19.8	19.9	19.4			
F20	52.4	52.8	53.7				34.3	34.1	34.3			
Bessemer Creek												
BS10	256	254	254				258	256	255			
Buck Creek												
BK10	51.5	49.1	49.9				47.8	47.4	46.9			
BK20				88.2	91.7	90.9				73.1	69.8	73.4
BK30				42.6	42.8	42.4				48	47.8	47.3
BK40				26.3	26.2	26				34	34.4	34.1

APPENDIX I

EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Al - mg/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	.59	.61	.58				.23	.26	.20			
F20	2.72	2.74	2.30				.29	.32	.30			
Bessemer Creek												
BS10	19.2	18.3	19.4				1.25	1.30	1.30			
Buck Creek												
BK10	.27	.23	.19				.27	.25	.49			
BK20				.78	.63	.65				.13	.12	.12
BK30				.11	.09	.10				.07	< .05	< .05
BK40				.92	1.0	.93				.29	.26	.28

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Al - mg/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	.15	.14	.14				.10	.11	.10			
F20	.08	.09	.08				.08	.08	.08			
Ressemer Creek												
BS10	1.67	1.70	1.67				.15	.16	.15			
Buck Creek												
BK10	< .05	< .05	< .05				.07	.09	.07			
BK20				.08	.07	.06				< .05	< .05	< .05
BK30				< .05	< .05	< .05				< .05	< .05	< .05
BK40				.06	< .05	.05				< .05	.06	< .05

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total As - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	< .5	< .5	< .5				-	-	-			
F20	6.8	6.9	8.2				-	-	-			
Bessemer Creek												
BS10	80.2	85.1	81.2				-	-	-			
Buck Creek												
BK10	2.2	1.1	1.2				-	-	-			
BK20				1.9	2.1	1.9				-	-	-
BK30				1.0	< .5	< .5				-	-	-
BK40				< .5	< .5	< .5				-	-	-

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved As - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	-	-	-				-	-	-			
F20	-	-	-				-	-	-			
Bessemer Creek												
BS10	-	-	-				-	-	-			
Buck Creek												
BK10	-	-	-				-	-	-			
BK20				-	-	-				-	-	-
BK30				-	-	-				-	-	-
BK40				-	-	-				-	-	-

APPENDIX I

EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Cd - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	< 0.6	< 0.6	< 0.6				< 0.5	< 0.5	< 0.5			
F20	< 0.6	< 0.6	< 0.6				< 0.5	< 0.5	< 0.5			
Bessemer Creek												
BS10	(10)	(10)	(11)				1.8	1.8	1.4			
Buck Creek												
BK10	< 0.6	< 0.6	< 0.6				< 0.5	< 0.5	< 0.5			
BK20				< 0.6	< 0.6	< 0.6				< 0.5	< 0.5	< 0.5
BK30				< 0.6	< 0.6	< 0.6				< 0.5	< 0.5	< 0.5
BK40				< 0.6	< 0.6	< 0.6				< 0.5	< 0.5	< 0.5

( ) = ICAP, otherwise AA

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Cd - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	< 0.5	< 0.5	< 0.5				< 0.5	< 0.5	< 0.5			
F20	< 0.5	< 0.5	< 0.5				< 0.5	< 0.5	< 0.5			
Bessemer Creek												
BS10	(13)	(13)	(14)				1.5	1.6	1.5			
Buck Creek												
BK10	< 0.5	< 0.5	< 0.5				< 0.5	< 0.5	< 0.5			
BK20				< 0.5	< 0.5	< 0.5				< 0.5	< 0.5	< 0.5
BK30				< 0.5	< 0.5	< 0.5				< 0.5	< 0.5	< 0.5
BK40				< 0.5	< 0.5	< 0.5				< 0.5	< 0.5	< 0.5

( ) = ICAP, otherwise AA

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Ca - mg/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	5.7	5.8	5.8				4.4	4.5	4.7			
F20	14.6	14.5	14.5				9.5	9.3	9.3			
Bessemer Creek												
BS10	69.8	69.8	70.1				73.7	72.1	71.4			
Buck Creek												
BK10	13.2	12.9	13.2				12.0	11.8	12.1			
BK20				25.0	24.5	24.7				18.6	18.6	17.7
BK30				11.7	11.6	11.7				12.4	12.8	12.5
BK40				6.7	6.7	6.7				8.1	8.1	8.2

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Ca - mg/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	6.1	6.0	5.9				4.7	4.7	4.6			
F20	14.2	14.3	14.5				9.6	9.6	9.6			
Bessemer Creek												
BS10	67.9	67.6	67.7				76.7	76.3	75.9			
Buck Creek												
BK10	13.7	13.0	13.3				12.9	12.7	12.6			
BK20				24.1	25.0	24.9				20.2	19.3	20.2
BK30				11.5	11.6	11.5				13.0	12.9	12.8
BK40				6.2	6.2	6.2				8.2	8.3	8.3

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Cr - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	< 6	< 6	< 6				< 5	< 5	< 5			
F20	< 6	< 6	< 6				< 5	< 5	< 5			
Bessemer Creek												
BS10	11	11	16				< 5	< 5	< 5			
Buck Creek												
BK10	< 6	< 6	< 6				< 5	< 5	< 5			
BK20				< 6	< 6	< 6				< 5	< 5	< 5
BK30				< 6	< 6	< 6				< 5	< 5	< 5
BK40				< 6	< 6	< 6				< 5	< 5	< 5

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Cr - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	< 5	< 5	< 5				< 5	< 5	< 5			
F20	< 5	< 5	< 5				< 5	< 5	< 5			
Bessemer Creek												
BS10	< 5	< 5	< 5				< 5	< 5	< 5			
Buck Creek												
BK10	< 5	< 5	< 5				< 5	< 5	< 5			
BK20				< 5	< 5	< 5				< 5	< 5	< 5
BK30				< 5	< 5	< 5				< 5	< 5	< 5
BK40				< 5	< 5	< 5				< 5	< 5	< 5

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Cu - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	6	4	< 1				< 1	< 1	< 1			
F20	(91)	(91)	(91)				2	2	2			
Bessemer Creek												
BS10	(2000)	(1990)	(2000)				(80)	(84)	(84)			
Buck Creek												
BK10	1	1	1				< 1	< 1	< 1			
BK20				(116)	(113)	(115)				< 1	1	1
BK30				(14)	3	8				2	1	2
BK40				2	2	2				< 1	< 1	< 1

( ) = ICAP, otherwise AA

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Cu - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	3	2	1				< 1	< 1	< 1			
F20	(58)	(56)	(59)				2	2	1			
Bessemer Creek												
BS10	(1550)	(1530)	(1530)				(49)	(48)	(49)			
Buck Creek												
BK10	(16)	3	2				< 1	< 1	< 1			
BK20				(73)	(78)	(77)				< 1	1	1
BK30				7	(12)	8				2	2	1
BK40				4	2	5				< 1	< 1	< 1

( ) = ICAP, otherwise AA

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Fe - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	526	563	513				180	187	191			
F20	2830	2820	2490				255	265	317			
Bessemer Creek												
BS10	25900	24900	26000				1220	1210	1190			
Buck Creek												
BK10	900	824	767				666	623	892			
BK20				1720	1530	1480				1160	1160	985
BK30				268	243	283				179	161	164
BK40				1150	1210	1150				457	435	449

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Fe - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	209	142	144				103	104	109			
F20	113	118	127				86	94	83			
Bessemer Creek												
BS10	1610	1610	1560				133	130	135			
Buck Creek												
BK10	486	470	477				429	426	435			
BK20				481	532	493				880	782	887
BK30				125	151	114				102	101	100
BK40				193	165	169				161	193	158

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Mg - mg/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	2.5	2.6	2.5				1.8	1.8	1.8			
F20	4.3	4.3	4.3				2.4	2.4	2.4			
Bessemer Creek												
BS10	19.3	19.1	19.3				14.8	14.9	14.4			
Buck Creek												
BK10	3.9	3.8	3.8				3.4	3.4	3.5			
BK20				6.6	6.4	6.4				4.9	4.9	4.7
BK30				3.3	3.3	3.3				3.6	3.7	3.6
BK40				2.7	2.7	2.7				3.2	3.2	3.2

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Mg - mg/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	2.4	2.4	2.4				1.7	1.8	1.7			
F20	3.8	3.8	3.9				2.3	2.3	2.3			
Ressemer Creek												
BS10	15.8	15.7	15.7				14.5	14.3	14.3			
Buck Creek												
BK10	3.9	3.7	3.8				3.4	3.4	3.4			
BK20				6.3	6.5	6.5				5.0	4.8	5.0
BK30				3.2	3.3	3.2				3.7	3.6	3.0
BK40				2.4	2.4	2.4				3.1	3.1	3.1

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Mn - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	17	17	17				9	9	9			
F20	230	231	229				15	15	15			
Bessemer Creek												
BS10	3190	3170	3190				638	625	616			
Buck Creek												
BK10	76	64	64				41	36	60			
BK20				261	252	244				114	114	96
BK30				19	18	19				12	12	12
BK40				73	74	73				29	29	29

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Mn - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	16	7	8				6	5	5			
F20	166	168	172				8	8	8			
Bessemer Creek												
BS10	2880	2850	2850				649	642	640			
Buck Creek												
BK10	69	45	46				28	25	25			
BK20				217	228	225				116	103	117
BK30				6	6	7				2	2	2
BK40				12	12	12				17	17	17

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Mo - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	< 6	< 6	< 6				< 5	< 5	< 5			
F20	< 6	< 6	< 6				< 5	< 5	< 5			
Bessemer Creek												
BS10	6	6	10				< 5	< 5	< 5			
Buck Creek												
BK10	< 6	< 6	< 6				< 5	< 5	< 5			
BK20				< 6	< 6	< 6				< 5	< 5	< 5
BK30				< 6	< 6	< 6				< 5	< 5	< 5
BK40				< 6	< 6	< 6				< 5	< 5	< 5

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Mo - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	9	< 5	< 5				< 5	< 5	< 5			
F20	< 5	< 5	< 5				< 5	< 5	< 5			
Bessemer Creek												
BS10	< 5	< 5	< 5				< 5	< 5	< 5			
Buck Creek												
BK10	< 5	< 5	< 5				< 5	< 5	< 5			
BK20				< 5	< 5	< 5				< 5	< 5	< 5
BK30				< 5	< 5	< 5				< 5	< 5	< 5
BK40				< 5	< 5	< 5				< 5	< 5	< 5

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Ni - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	< .02	< .02	< .02				< .02	< .02	< .02			
F20	< .02	< .02	< .02				< .02	< .02	< .02			
Bessemer Creek												
BS10	.17	.17	.21				.06	.05	.06			
Buck Creek												
BK10	< .02	< .02	< .02				< .02	< .02	< .02			
BK20				< .02	< .02	< .02				< .02	< .02	< .02
BK30				< .02	< .02	< .02				< .02	< .02	< .02
BK40				< .02	< .02	< .02				< .02	< .02	< .02

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Ni - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	< .02	< .02	< .02				< .02	< .02	< .02			
F20	< .02	< .02	< .02				< .02	< .02	< .02			
Bessemer Creek												
BS10	.15	.15	.16				.06	.06	.06			
Buck Creek												
BK10	< .02	< .02	< .02				< .02	< .02	< .02			
BK20				< .02	< .02	< .02				< .02	< .02	< .02
BK30				< .02	< .02	< .02				< .02	< .02	< .02
BK40				< .02	< .02	< .02				< .02	< .02	< .02

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Pb - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	< 1	< 1	< 1				< 1	< 1	< 1			
F20	< 1	< 1	< 1				< 1	< 1	< 1			
Bessemer Creek												
BS10	< 1	< 1	< 1				< 1	< 1	< 1			
Ruck Creek												
BK10	< 1	< 1	< 1				< 1	< 1	< 1			
BK20				< 1	< 1	< 1				< 1	< 1	< 1
BK30				< 1	< 1	5				< 1	< 1	< 1
BK40				< 1	1	1				< 1	< 1	< 1

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Pb - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	< 1	< 1	< 1				< 1	< 1	< 1			
F20	< 1	< 1	< 1				< 1	< 1	< 1			
Bessemer Creek												
BS10	< 1	< 1	< 1				< 1	< 1	< 1			
Buck Creek												
BK10	< 1	< 1	< 1				< 1	< 1	< 1			
BK20				< 1	< 1	< 1				< 1	< 1	< 1
BK30				< 1	< 1	1				< 1	< 1	< 1
BK40				< 1	1	1				< 1	< 1	< 1

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Sr - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	69	70	69				47	47	49			
F20	284	283	282				180	181	184			
Bessemer Creek												
BS10	1540	1530	1540				3400	3200	3270			
Buck Creek												
BK10	133	123	124				132	126	132			
BK20				360	355	353				297	294	275
BK30				133	132	132				153	163	157
BK40				58	58	58				77	77	78

APPENDIX I

EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Sr - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	71	71	71				50	50	49			
F20	285	286	297				185	187	184			
Bessemer Creek												
BS10	1590	1560	1570				3620	3540	3560			
Buck Creek												
BK10	146	131	135				154	139	140			
BK20				372	396	387				327	308	330
BK30				138	138	138				162	160	156
BK40				55	55	54				76	74	74

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Ti - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	24	24	22				10	9	9			
F20	86	86	69				10	11	12			
Bessemer Creek												
BS10	370	347	390				21	23	22			
Buck Creek												
BK10	4	5	4				9	9	18			
BK20				12	9	7				5	5	5
BK30				< 2	2	3				< 2	< 2	< 2
RK40				49	53	47				15	14	15

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Dissolved Ti - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	< 2	< 2	< 2				2	3	3			
F20	< 2	< 2	< 2				< 2	2	< 2			
Bessemer Creek												
BS10	< 2	< 2	< 2				< 2	< 2	< 2			
Buck Creek												
BK10	< 2	< 2	< 2				2	< 2	3			
BK20				< 2	< 2	< 2				< 2	< 2	< 2
BK30				< 2	< 2	< 2				< 2	< 2	< 2
BK40				< 2	< 2	< 2				< 2	2	< 2

APPENDIX I EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS

Parameter (Total Zn - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	4	3	3				< 2	< 2	< 2			
F20	117	115	115				< 2	< 2	< 2			
Bessemer Creek												
BS10	1400	1390	1400				194	192	190			
Buck Creek												
BK10	8	< 2	< 2				< 2	< 2	< 2			
BK20				70	71	84				< 2	< 2	< 2
BK30				6	7	18				2	3	2
BK40				3	16	4				2	< 2	< 2

APPENDIX I **EQUITY SILVER - RECEIVING WATER QUALITY DATA FOR CREEKS**

Parameter (Dissolved Zn - ug/l)

STATION	July 21, 1982			July 22, 1982			July 18, 1983			July 19, 1983		
	REPLICATE			REPLICATE			REPLICATE			REPLICATE		
	1	2	3	1	2	3	1	2	3	1	2	3
Foxy Creek												
F10	3	3	3				8	2	< 2			
F20	85	78	79				3	3	3			
Bessemer Creek												
BS10	1210	1210	1210				131	132	131			
Buck Creek												
BK10	10	< 2	< 2				2	< 2	< 2			
BK20				53	54	53				3	< 2	< 2
BK30				5	7	4				< 2	< 2	< 2
BK40				< 2	< 2	< 2				< 2	< 2	< 2

APPENDIX II

GOOSLY LAKE WATER CHEMISTRY

APPENDIX II GOOSLY LAKE WATER CHEMISTRY

Conductivity, Turbidity, Temperature, Total Residue, Non-Filterable Residue, Sulfate

STATION	PARAMETER													
	DEPTH (m)		CONDUCTIVITY (umhos/cm)		TURBIDITY (JTU)		TEMPERATURE (°C)		TOTAL RESIDUE (mg/l)		NON-FILTERABLE RESIDUE (mg/l)		SULFATE (mg/l)	
	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19
Goosly Lake														
GL10	1	1	101	107	0.9	0.8	-	13	96	100	< 5	< 5	16.0	17.3
	3	3	102	111	0.8	0.8	-	-	97	102	< 5	< 5	15.7	17.8
	5	-	101	-	0.8	-	-	-	101	-	< 5	-	15.7	-
	8	8	97.0	103	0.8	2.5	-	-	102	101	< 5	5	15.2	16.1
GL20	1	1	102	109	1.0	0.2	-	18	99	97	< 5	< 5	16.0	17.0
	3	3	103	109	1.0	0.8	-	-	101	101	< 5	< 5	15.6	17.0
	5	-	104	-	0.7	-	-	-	100	-	< 5	-	16.5	-
	8	8	103	105	1.0	0.8	-	-	97	99	< 5	< 5	15.8	16.7
GL30	1	1	100	106	0.8	0.7	-	18	111	98	< 5	< 5	15.2	16.9
	3	3	100	106	0.7	0.7	-	-	115	105	< 5	< 5	15.4	17.1
	5	-	100	-	0.7	-	-	-	110	-	< 5	-	15.3	-
	8	8	100	104	1.0	0.8	-	-	111	100	< 5	< 5	15.4	15.8

APPENDIX II GOOSLY LAKE WATER CHEMISTRY

pH, Hardness, Aluminum, Arsenic

STATION	PARAMETER															
	DEPTH (m)		pH				HARDNESS		Al (mg/l)				As (ug/l)			
			Lab		Field		(mg/l $CaCO_3$)		Total		Dissolved		Total		Dissolved	
	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19
Goosly Lake																
GL10	1	1	7.2	7.5	7.6	7.8	43.3	48.4	.08	.07	< .05	< .05	0.6	-	-	-
	3	3	7.2	7.3	7.6	7.1	43.9	50	.08	.09	< .05	< .05	0.6	-	-	-
	5	-	7.2	-	7.5	-	43.4	-	.10	-	< .05	-	0.6	-	-	-
	8	8	7.2	7.0	7.2	7.0	42.8	45.8	.22	.19	< .05	< .05	< 0.5	-	-	-
GL20	1	1	7.2	7.6	7.6	8.4	43.5	47.4	.11	< .05	< .05	< .05	.63	-	-	-
	3	3	7.3	7.5	7.5	8.4	43.8	48.5	.10	.06	< .05	< .05	< .5	-	-	-
	5	-	7.3	-	7.5	-	43.6	-	.09	-	< .05	-	.53	-	-	-
	8	8	7.3	7.1	7.5	7.9	43.3	46.1	.12	.08	< .05	< .05	.59	-	-	-
GL30	1	1	7.3	7.6	7.7	8.5	42	47.5	< .06	< .05	< .05	< .05	.55	-	-	-
	3	3	7.3	7.5	7.8	8.1	41.8	47.6	< .06	.05	< .05	< .05	< .5	-	-	-
	5	-	7.3	-	7.6	-	42.1	-	< .06	-	< .05	-	< .5	-	-	-
	8	8	7.3	7.1	7.2	7.8	41.3	46.3	.08	.07	< .05	< .05	< .5	-	-	-

APPENDIX II GOOSLY LAKE WATER CHEMISTRY

Cadmium, Calcium, Chromium

STATION	PARAMETER															
	DEPTH (m)		Cd (ug/l)				Ca (mg/l)				Cr (ug/l)					
			Total		Dissolved		Total		Dissolved		Total		Dissolved			
	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19		
Goosly Lake																
GL10	1	1	< 0.6	< 0.5	< 0.6	< 0.5	11.9	12.8	11.8	13.1	< 6	< 5	< 5	< 5		
	3	3	< 0.6	< 0.5	< 0.6	< 0.5	11.8	13.2	11.7	13.6	< 6	< 5	< 5	< 5		
	5	-	< 0.6	-	< 0.6	-	11.7	-	11.6	-	< 6	-	< 5	-		
	8	8	< 0.6	< 0.5	< 0.6	< 0.5	11.6	12.1	11.4	12.4	< 6	< 5	< 5	< 5		
GL20	1	1	< 0.6	< 0.5	< 0.6	< 0.5	11.9	12.5	11.7	12.5	< 6	< 5	< 5	< 5		
	3	3	< 0.6	< 0.5	< 0.6	< 0.5	11.8	12.7	11.7	12.9	< 6	< 5	< 5	< 5		
	5	-	< 0.6	-	< 0.6	-	12.0	-	11.7	-	< 6	-	< 5	-		
	8	8	< 0.6	< 0.5	< 0.6	< 0.5	11.9	12.3	11.6	12.9	< 6	< 5	< 5	< 5		
GL30	1	1	< 0.6	< 0.5	< 0.6	< 0.5	11.6	12.5	11.2	12.5	< 6	< 5	< 5	< 5		
	3	3	< 0.6	< 0.5	< 0.6	< 0.5	11.6	12.5	11.2	13.2	< 6	< 5	< 5	< 5		
	5	-	< 0.6	-	< 0.6	-	11.5	-	11.2	-	< 6	-	28	-		
	8	8	< 0.6	< 0.5	< 0.6	< 0.5	11.6	12.0	11.0	12.8	< 6	< 5	< 5	< 5		

APPENDIX II GOOSLY LAKE WATER CHEMISTRY

Copper, Iron, Magnesium

STATION	PARAMETER															
	DEPTH (m)		Cu (ug/l)				Fe (ug/l)				Mg (mg/l)			
			Total		Dissolved		Total		Dissolved		Total		Dissolved	
	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19
Goosly Lake														
GL10	1	1	4	3	5	2	267	208	141	117	3.3	3.7	3.3	3.7
	3	3	4	2	6	2	262	295	149	161	3.3	3.8	3.4	3.8
	5	-	4	-	6	-	260	-	152	-	3.3	-	3.4	-
	8	8	4	2	8	2	410	426	143	111	3.3	3.5	3.3	3.5
GL20	1	1	(12)	2	6	2	333	168	149	110	3.3	3.6	3.4	3.7
	3	3	5	3	6	2	294	224	158	131	3.3	3.7	3.4	3.6
	5	-	4	-	5	-	312	-	152	-	3.4	-	3.4	-
	8	8	5	2	6	2	318	217	154	103	3.3	3.6	3.3	3.6
GL30	1	1	4	1	7	2	202	164	124	103	3.3	3.6	3.3	3.5
	3	3	4	1	4	1	210	170	121	101	3.3	3.6	3.2	3.6
	5	-	6	-	7	-	205	-	220	-	3.3	-	3.2	-
	8	8	4	4	8	2	230	198	125	96	3.3	3.5	3.2	3.6

( ) = ICAP, otherwise AA

APPENDIX II GOOSLY LAKE WATER CHEMISTRY

Manganese, Molybdenum, Lead

STATION	DEPTH (m)		Mn (ug/l)				Mo (ug/l)				Pb (ug/l)			
			Total		Dissolved		Total		Dissolved		Total		Dissolved	
	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19
Goosly Lake														
GL10	1	1	15	18	7	3	< 6	< 5	< 5	< 5	< 1	< 1	< 1	< 1
	3	3	15	28	4	10	< 6	< 5	< 5	< 5	< 1	< 1	< 1	< 1
	5	-	15	-	4	-	< 6	-	< 5	-	< 1	-	< 1	-
	8	8	26	110	10	62	< 6	< 5	< 5	< 5	< 1	< 1	< 1	< 1
GL20	1	1	18	13	6	3	< 6	< 5	< 5	< 5	< 1	< 1	< 1	< 1
	3	3	17	21	6	5	< 6	< 5	< 5	< 5	< 1	< 1	< 1	< 1
	5	-	18	-	6	-	< 6	-	< 5	-	< 1	-	< 1	-
	8	8	20	37	6	10	< 6	< 5	< 5	< 5	< 1	< 1	< 1	< 1
GL30	1	1	11	13	< 1	1	< 6	< 5	< 5	< 5	< 1	< 1	< 1	< 1
	3	3	11	14	< 1	1	< 6	< 5	< 5	< 5	< 1	< 1	< 1	< 1
	5	-	11	-	2	-	< 6	-	< 5	-	< 1	-	< 1	-
	8	8	18	36	6	6	< 6	< 5	< 5	< 5	< 1	< 1	< 1	< 1

APPENDIX II GOOSLY LAKE WATER CHEMISTRY

Strontium, Titanium, Zinc

STATION	PARAMETER															
	DEPTH (m)		Sr (ug/l)				Ti (ug/l)				Zn (ug/l)			
			Total		Dissolved		Total		Dissolved		Total		Dissolved	
	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19	1982 July 22	1983 July 19
Goosly Lake														
GL10	1	1	136	162	147	164	< 2	< 2	< 2	< 2	7	4	7	< 2
	3	3	135	174	148	176	< 2	3	< 2	< 2	4	3	4	< 2
	5	-	132	-	146	-	< 2	-	< 2	-	5	-	3	-
	8	8	129	146	141	146	4	9	< 2	< 2	10	6	5	< 2
GL20	1	1	136	158	148	158	< 2	< 2	< 2	< 2	6	< 2	6	< 2
	3	3	136	162	149	166	< 2	< 2	< 2	< 2	3	3	5	< 2
	5	-	139	-	148	-	< 2	-	< 2	-	4	-	4	-
	8	8	136	151	147	150	< 2	2	< 2	< 2	4	3	4	< 2
GL30	1	1	131	158	139	159	< 2	< 2	< 2	< 2	2	6	3	< 2
	3	3	131	156	139	158	< 2	< 2	< 2	< 2	9	< 2	4	< 2
	5	-	131	-	138	-	< 2	-	< 2	-	6	-	4	-
	8	8	130	144	134	149	< 2	3	< 2	< 2	3	5	3	3